2005 Distance Sampling
Perceived Threat Data Analyses

Submitted to USFWS
Robert D. Williams, Field Supervisor
Roy Averill-Murray, DTRO
1340 Financial Blvd, Suite 234
Reno, NV 89502

By

Dr. Jill S Heaton
University of Nevada, Reno
Department of Geography/154
Reno, NV 89557

29 January 2007

EXECUTIVE SUMMARY

The 2005 Distance Sampling effort included the collection of data on perceived threats to the desert tortoise (U.S. Fish and Wildlife Service, 2006). This included exotic vegetation species, information on different dirt road types, trash, ravens, and canids. These data represent the most comprehensive attempt to date to produce a spatial inventory of these perceived threats to desert tortoises. This report provides a first-cut summary of the spatial distribution of these threats using simple spatial interpolation methods.

In general, areas with the highest road counts were concentrated in the Western Mojave Recovery Unit (RU), particularly in the Fremont-Kramer, Superior-Cronese, and Ord-Rodman critical habitat units, in that order. However, other areas of high road counts were found along major highways, major road intersections, and within smaller portions of other Desert Wildlife Management Areas. Single tracks were more prevalent in the Western and Eastern Mojave RUs, while double tracks were more prevalent in the Eastern and Northern Colorado RUs.

Mediterranean grass (*Schismus* spp.) was prevalent across the entire sample area. Non-native mustard (*Brassica tournefortii*) appears to be restricted, with few exceptions, to the Colorado Desert, while brome (*Bromus* spp.) appears to be restricted, also with few exceptions, to the Mojave Desert. The probability of finding trash was very low throughout the entire sampled area; however where it was present it was almost exclusively associated with populated areas. Along the approximately 9100 km walked in 2005, only three canids were observed. The highest concentration of ravens was observed in the Western Mojave RU, in particular the southern portion of Fremont-Kramer. Otherwise, raven observations were very low, if any were even observed, throughout most of the remaining sample area.

INTRODUCTION

In response to management inquiry and recommendations from the Desert Tortoise Recovery Plan Assessment Committee (DTRPAC; Tracy et al., 2004), additional data, non-specific to distance sampling, were collected during distance-sampling surveys in 2005 (U.S. Fish and Wildlife Service, 2006). In particular, the variables were selected to describe perceived threats to desert tortoises. These data included the presence or absence of exotic vegetation species (i.e. *Brassica tournefortii*, *Schismus* spp., and *Bromus* spp.), vehicle tracks, and trash (this does not include trash that has blown in), and the number of ravens, canids, graded roads (i.e., a road with a berm along the outer edge), ungraded roads (i.e., a road without a berm), single-track single-pass (i.e., a motorcycle passing once over the ground leaving a single track), single-track multi-pass (i.e., a well established motorcycle trail with many bikes making the trail rutted and wider than a single tire print), double-track single-pass (i.e., a four-wheel vehicle, car, jeep, or ATV passing over the ground once leaving 2 sets of tracks), and double-track multi-pass (i.e., a four-wheel trail with many passes, but not as well established as an ungraded road).

The DTRPAC report (Tracy et al., 2004) emphasized the importance of the cumulative, interactive, and synergistic properties of threats. In addition, the report called for the development and use of innovative visualization analysis techniques for exploring the temporal and spatial complexities of individual and interactive threats. Tortoise monitoring prior to 2005 suffered from its focus on a single dimension—density. The DTRPAC report identified a successful tortoise monitoring program as multi-dimensional, multi-scaled, recovery-focused, and adaptively managed, and recommended that in addition to tortoises it include monitoring of the extent and condition of habitat and impacts (i.e., perceived threats) to tortoises. The collection and subsequent preliminary analysis of these data, as presented in this report, represents the first step towards meeting the challenge of a successful tortoise monitoring program as put forth by the DTRPAC.

METHODS

The ArcGIS Spatial Analyst tool Kriging, with default options, was used for all analyses (i.e., method = ordinary; semivariogram model = spherical; search radius = variable; and number of points = 12). Kriging is built on the basic principle that things that are close to one another are more alike than those farther away (quantified as spatial autocorrelation). Output cell size was 1 km^2, and so results are units/ km^2. Ordinary Kriging produces interpolation values by assuming a constant but unknown mean value, allowing local influence due to nearby neighbor values. Because the mean is unknown there are few assumptions. This makes Ordinary Kriging particularly flexible, but perhaps less powerful than other methods. The decision to use Ordinary Kriging for these analyses was based on its simplicity. I recommend that other methods, particularly lognormal, be investigated before comparison with tortoise distributions. Note that the use of other kriging methods will not change the relative trend in predicted values (e.g., more over here than over there), but will affect the absolute predicted value of each cell.

Schismus spp., *Bromus* spp., *Brassica tournefortii*, vehicle tracks, and trash were recorded as present/absent at each waypoint (every 500 m) along each 12-km transect. The waypoint points were the input into the analysis. The resulting models produced a probability between 0 and 1 that the variable was found within each cell. At each waypoint field crews searched for ravens in the vicinity and recorded the number. They did not search for ravens while walking between waypoints. At each waypoint field crews recorded the total number of each road type traversed between that waypoint and the previous one. For ravens and roads the data were summarized to the transect level (i.e., sum of all observations at all waypoints associated with transect), and a single count representing each transect was the input. These models produced a predicted total number for the variable within each cell. The raven and roads data were all positively skewed (i.e., long tail to the right). In addition, many of the road variables contained very large positive outliers. For example, the total number of single-track single-pass roads recorded on any one transect ranged from 0 to 1016, with well over half of the transects recording 0 (Figure 1).

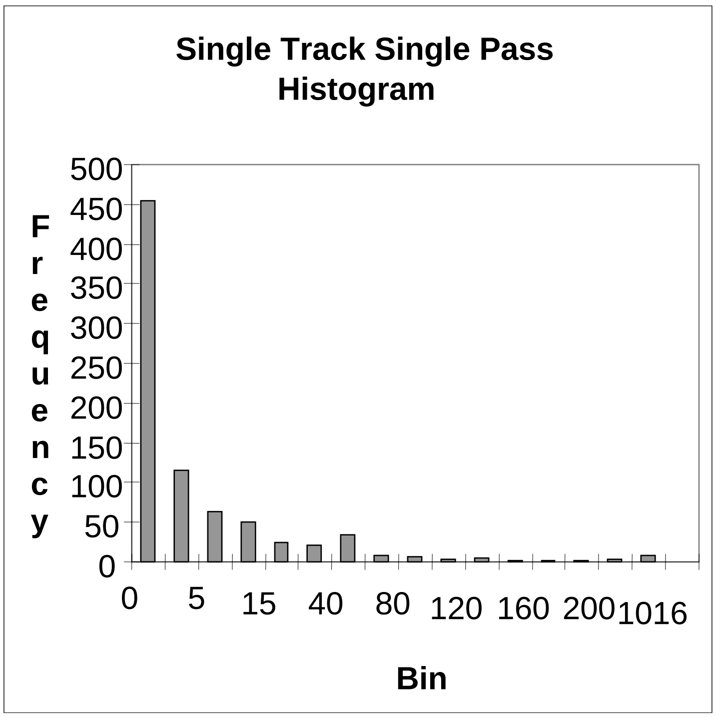

Figure 1. Frequency of single-track single pass roads within transect-level observation bins.

Extreme outliers can dominate the interpolation process to such an extent that the resulting model fails to adequately represent the true spatial structure of the data. As a result, all transects with road values of >200 were excluded from their respective analysis. For display purposes only, excluded transects were symbolized on the maps along with their values in a separate table. No transects were excluded from the raven analysis. An interpolation of the canid data was not possible due to the fact that only three canids were observed. For more detailed information on how these data were collected refer to the *2005 Handbook for Monitoring Desert Tortoise Populations Using the Line Distance Sampling Technique*.

RESULTS AND DISCUSSION

Probability of Finding Tracks

The probability of finding tracks per 1 km^2 was the highest in the Western Mojave RU, in particular the Fremont-Kramer, Superior-Cronese, and Ord-Rodman critical habitat units (Figure 2). This was followed by Chuckwalla and Piute-Eldorado critical habitat units, in the Northern Colorado and Eastern Mojave RUs, respectively. There are sporadic areas of high probability within the Northern Colorado and Northern Mojave RUs. The arrow pointing to the red area of high probability in the north portion of Lake Mead (Figure 2) is an artifact of a few sample points with tracks surrounded by an area that had no sample points. There were no transects within that portion of Lake Mead National Recreation Area, and as a result the prediction of a high probability of finding a track is not reliable.

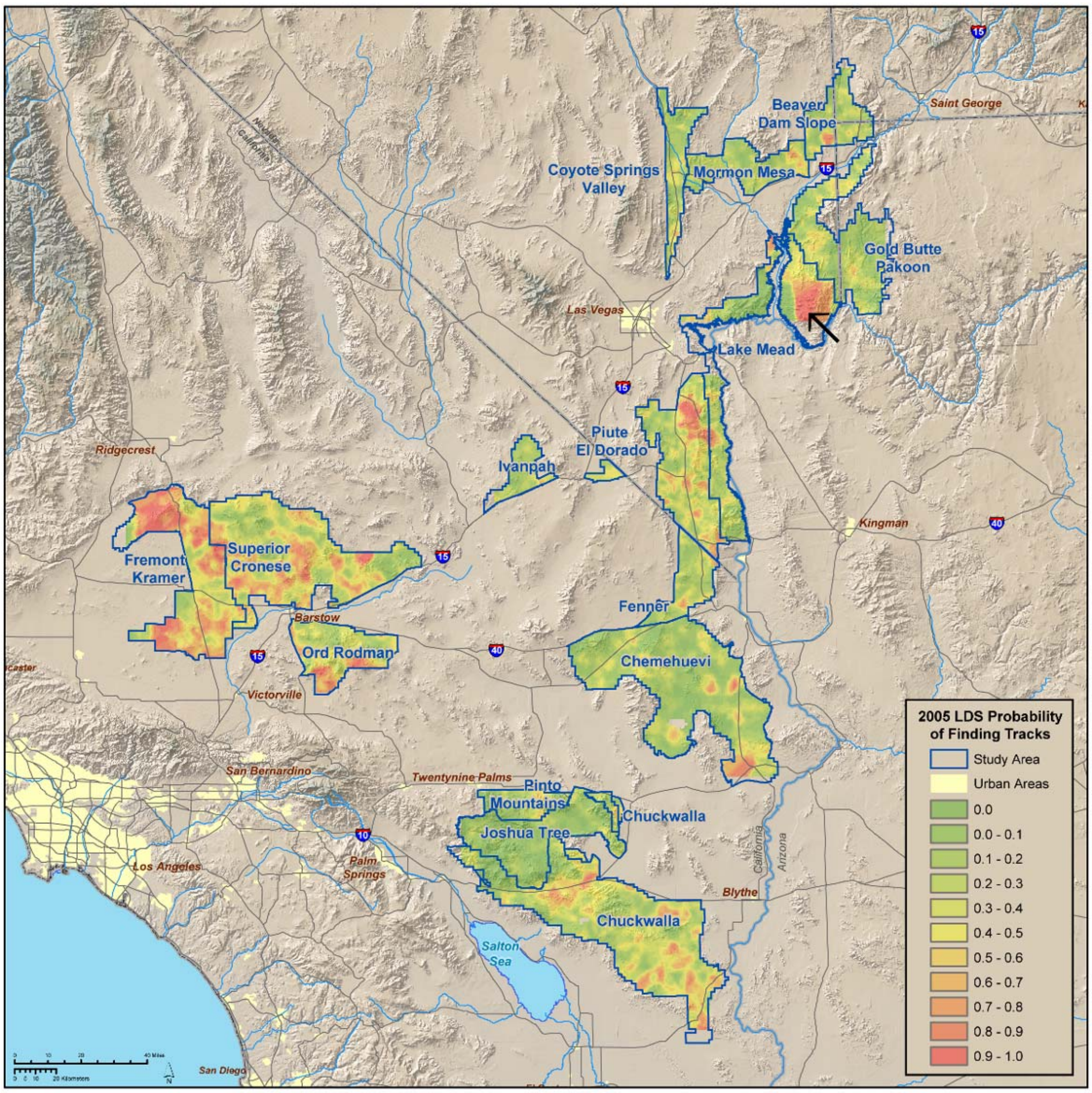

Figure 2. Probability of finding tracks per 1 km^2. Refer to text for information on annotated arrow within the north portion of Lake Mead National Recreation Area.

Graded Roads

Graded roads were most often found adjacent to populated areas (Figure 3).

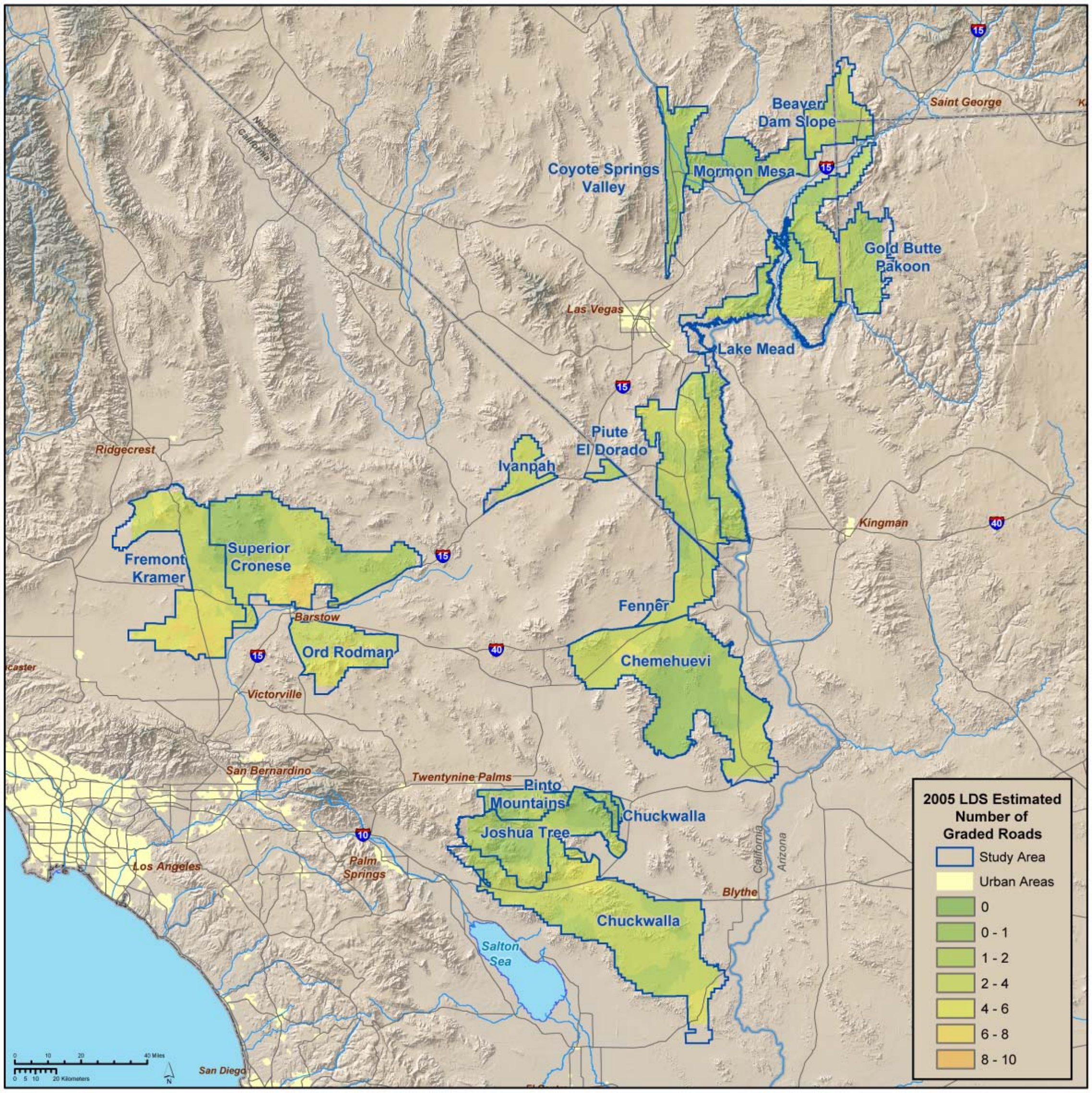

Figure 3. Estimated number of graded roads per 1 sq km.

Ungraded Roads

Ungraded roads were the highest in the northern portions of Fremont-Kramer around the Rand Area Mining District (Figure 4). Moderate numbers of ungraded roads were found in the southern portion of Fremont-Kramer, central Superior-Cronese, Ord-Rodman, and smaller areas in Chuckwalla and Piute-Eldorado.

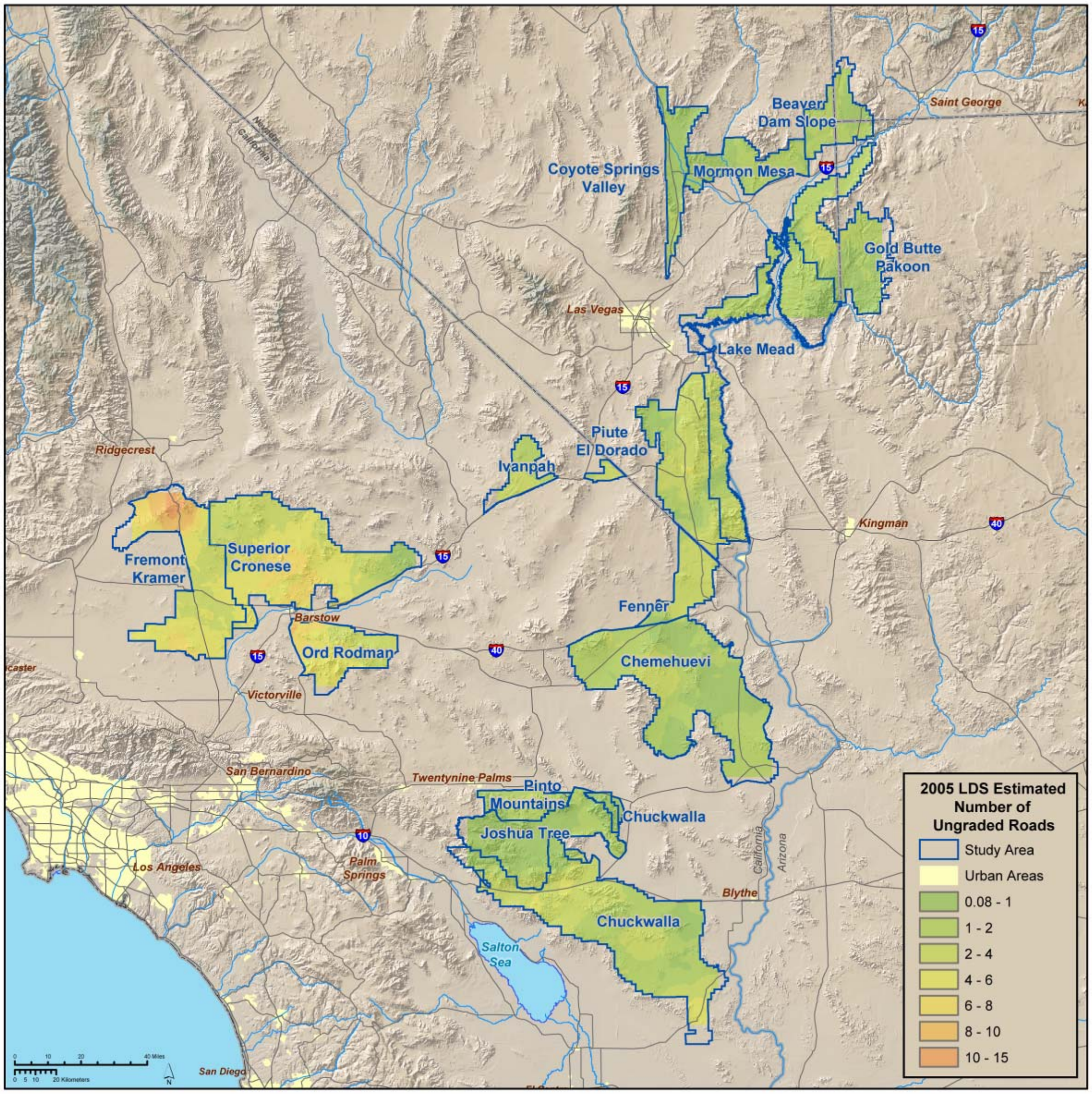

Figure 4. Estimated number of ungraded roads per 1 km^2.

Combined Graded and Ungraded Roads

The combined graded and ungraded roads data represent the composite of all dirt roads that are likely regularly or well traveled within the sample area. This would likely include all utility corridors, designated routes and private access roads. The highest concentration of these well traveled roads is within the Western Mojave RU and a small portion of Chuckwalla where it is intersected by Hwy 78 (Figure 5).

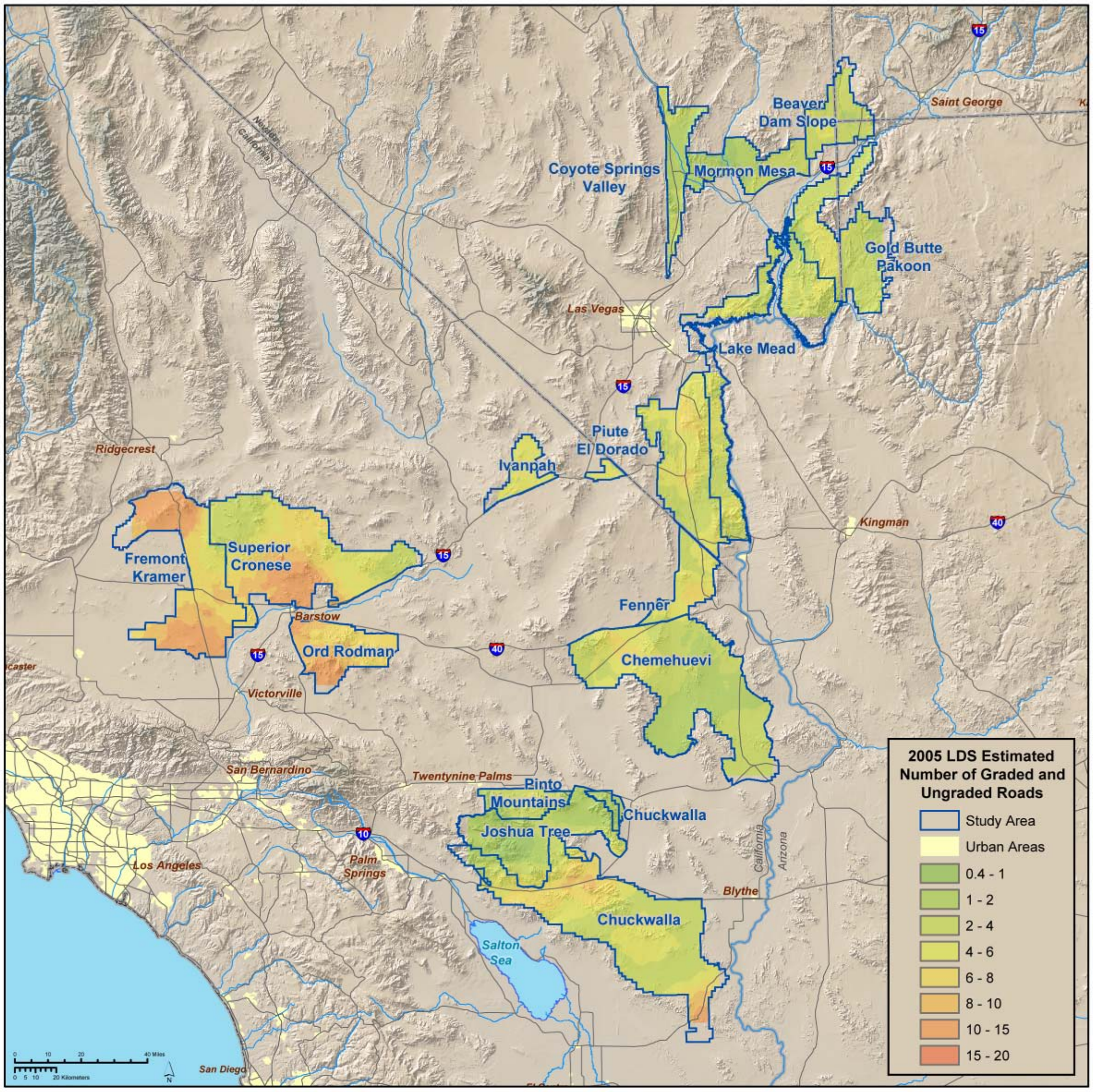

Figure 5. Estimated number of combined graded and ungraded roads per 1 km^2.

Single-Track Single-Pass Roads

Activities resulting in high numbers of single-track single-pass roads were almost exclusively restricted to the Western Mojave RU (Figure 6). This includes most specifically the northern half of Fremont-Kramer, along with areas to the south, portions of Superior-Cronese and Ord-Rodman. All but one of the outliers was restricted to Fremont-Kramer (max = 1016). The single outlier in Ord-Rodman was the lowest of the group (230). Ord-Rodman is bordered on the west by Stoddard Valley Open OHV area and on the south by Johnson Valley Open OHV area, both likely the cause of elevated numbers along those edges of Ord-Rodman. In the Eastern Mojave RU these roads were restricted to areas around Searchlight, Laughlin, and Bullhead City. The only other area of high concentration was in the Northeastern Mojave RU in the southern tip of Coyote Springs Valley along Hwy 93. There appears to be a low number of these types of tracks within Chuckwalla.

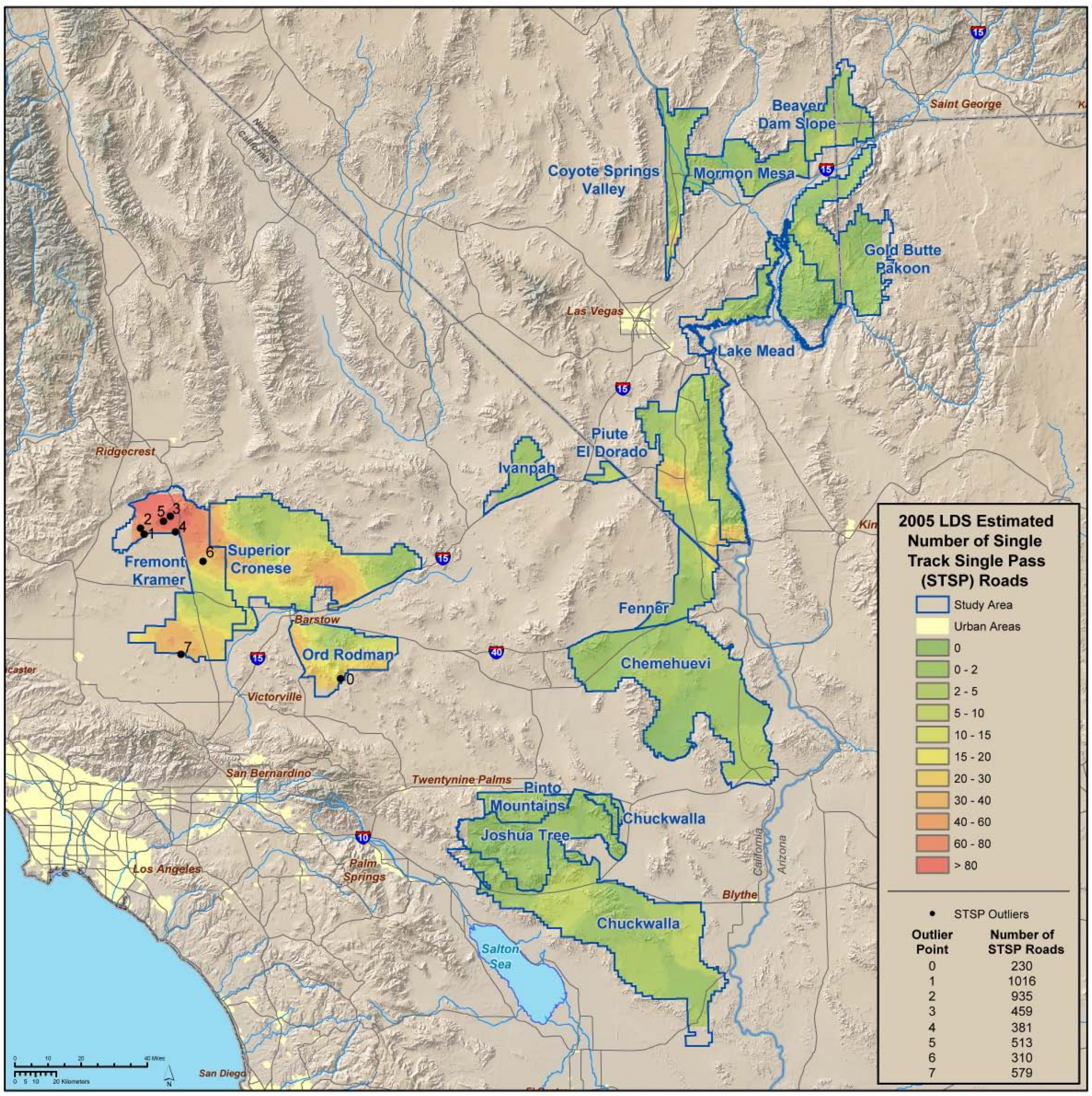

Figure 6. Estimated number of single-track single-pass roads per 1 km^2.

Single-Track Multi-Pass Roads

The general relative pattern of high vs. low concentrations, though not the same absolute values, of single-track multi-pass roads follows that of single-track single-pass roads with a few exceptions (Figure 7). These exceptions include Chuckwalla, Searchlight, and along Hwy 93 in southern Coyote Springs Valley. One possible reason for this difference is that the initiation of illegal off-road motorcycle travel is just beginning in these areas, meaning that well-traveled single-track routes, at the time of survey, had not yet been established in these areas. Subsequent surveys in these areas to monitor the transition, and if possible cessation, of conversion from single-pass to multi-pass roads should be conducted. As with the single-track single-pass roads, the pattern of higher concentration along the western and southern edges of Ord-Rodman are likely due to spillover from the bordering open OHV areas. Three outliers, all within the West Mojave RU, were removed before analysis.

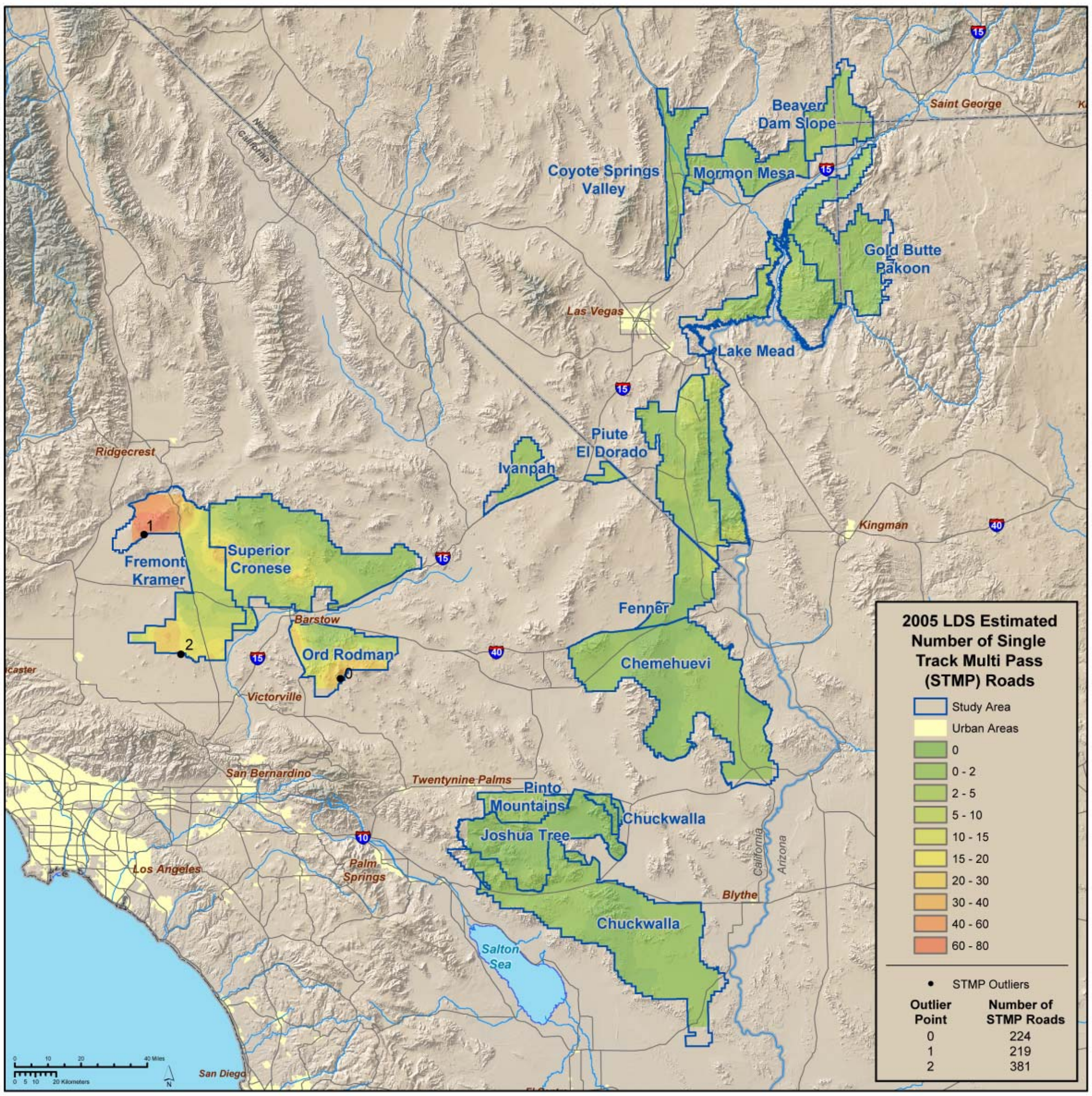

Figure 7. Estimated number of single track multi-pass roads per 1 sq km.

All Single-Track Roads

The combined data of all single-track roads represents the extent of known, and most likely illegal, motorcycle activity within the study area (Figure 8). Wash travel is allowed in Chuckwalla and Chemehuevi. The encroachment of single tracks into Ord-Rodman is most likely spillover from the adjacent OHV areas. It is worth noting, however, that despite being bordered by the Imperial Sand Dunes Open OHV area there appears to be almost no single-track spillover into Chuckwalla. Twelve outliers were removed before analysis, all within the West Mojave RU.

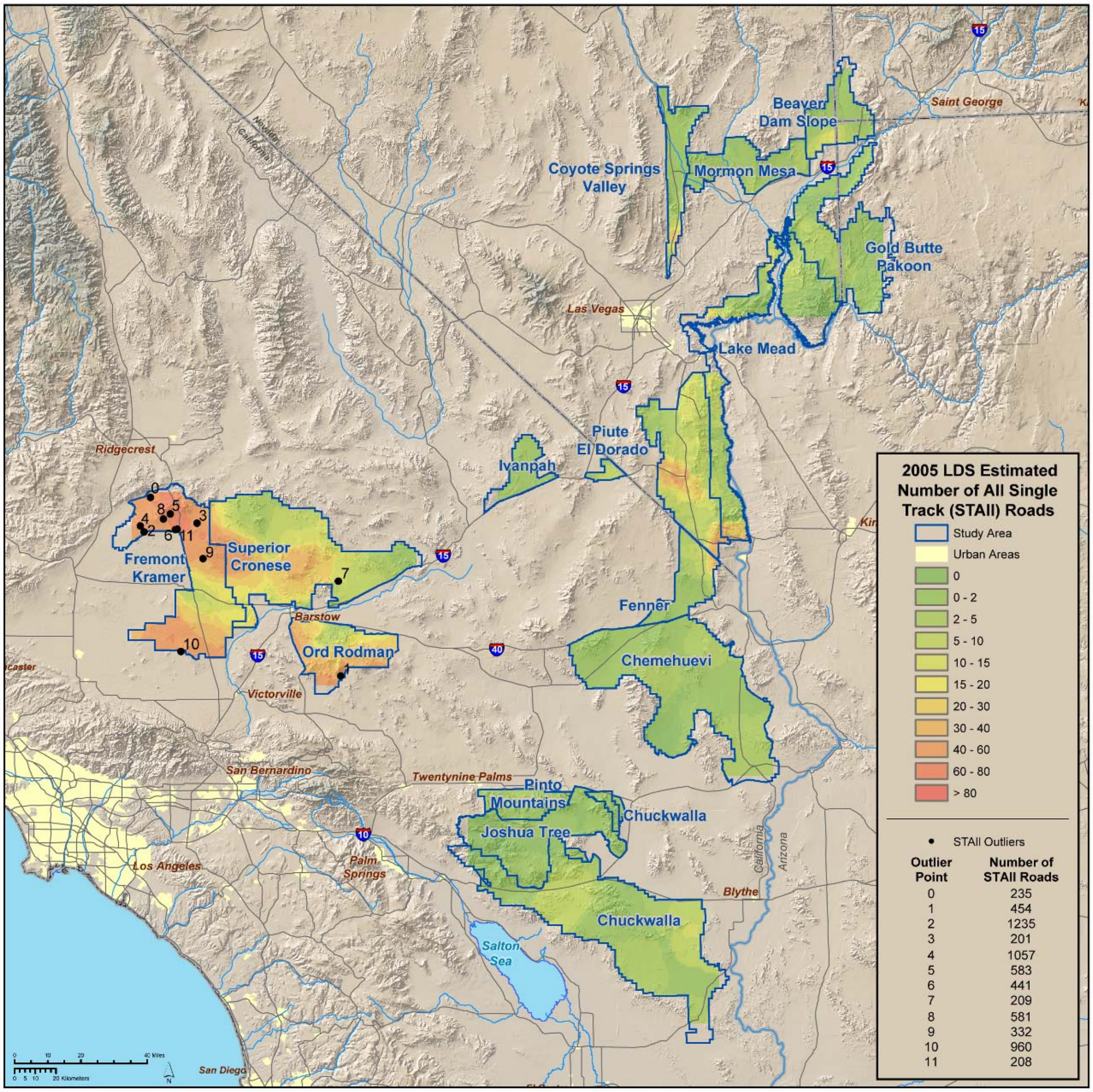

Figure 8. Estimated number of all single track roads per 1 km^2.

Double-Track Single-Pass Roads

The highest concentration of double-track single-pass roads is within the Eastern and Northern Colorado RUs, followed by the Western Mojave RU (Figure 9). Five outliers were removed from the analysis. The two within Superior-Cronese are likely spill-over from the Army Ft. Irwin National Training Center.

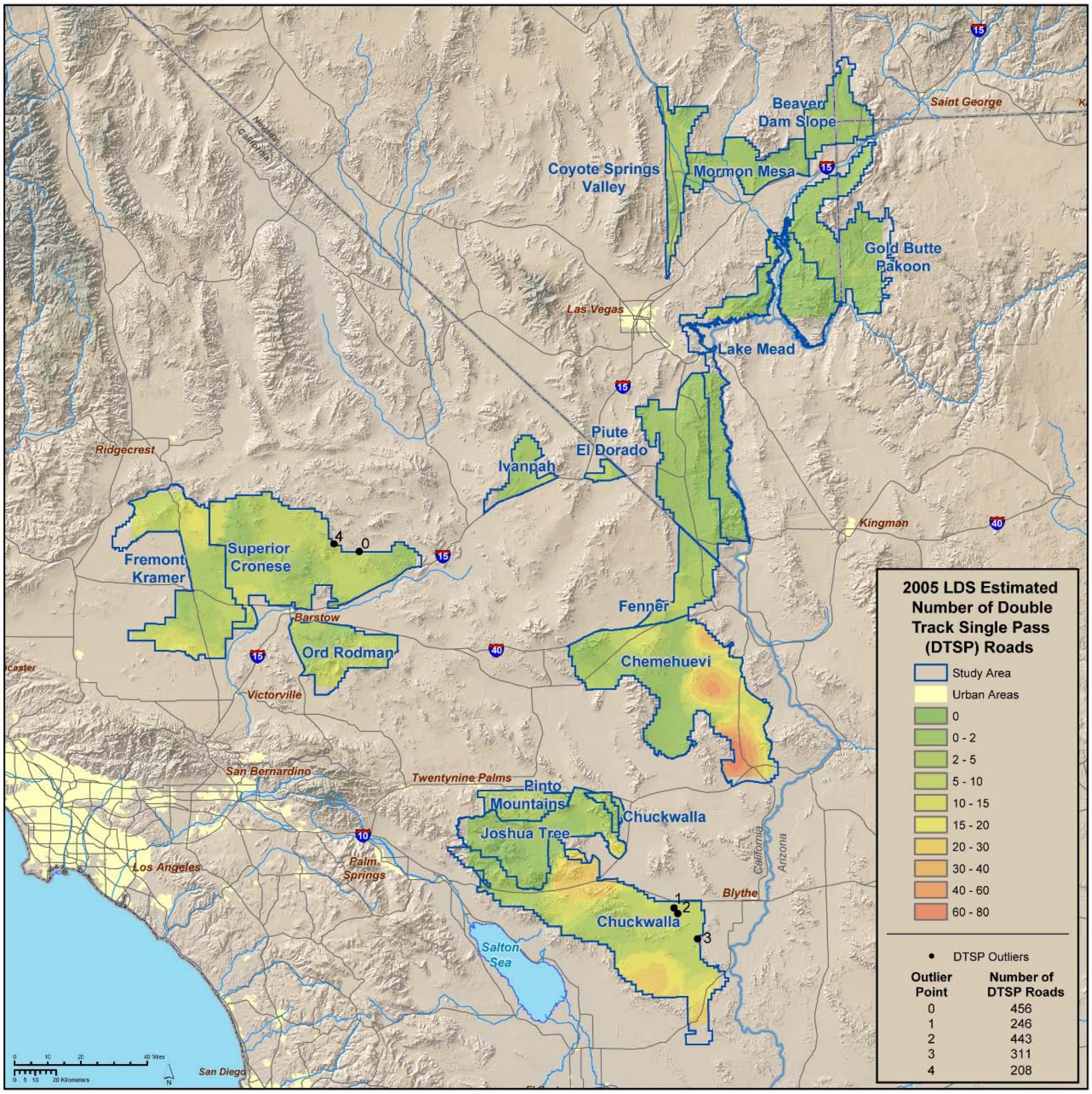

Figure 9. Estimated number of double-track single-pass roads per 1 km^2.

Double-Track Multi-Pass Roads

High concentrations of double-track multi-pass roads were found in virtually all RUs with the exception of the Northeastern Mojave (Figure 10). Highest concentrations are within Chuckwalla, small portions of Fremont-Kramer, Superior-Cronese, Ord-Rodman, and Piute-Eldorado, and the lower portions of Chemehuevi. High numbers in Ord-Rodman are likely due to spillover from Johnson Valley Open OHV area and Fremont-Kramer due to adjacency to Victorville and Apple Valley. The high numbers of roads in Chuckwalla are not found adjacent to Imperial Valley Sand Dunes Open OHV area, though the southern portions along Hwy 78 could be spillover. The high numbers in northern Chuckwalla between Chiriaco Summit, where the George S. Patton Memorial Museum is, and Desert Center are at least in part within the boundaries of Joshua Tree National Park.

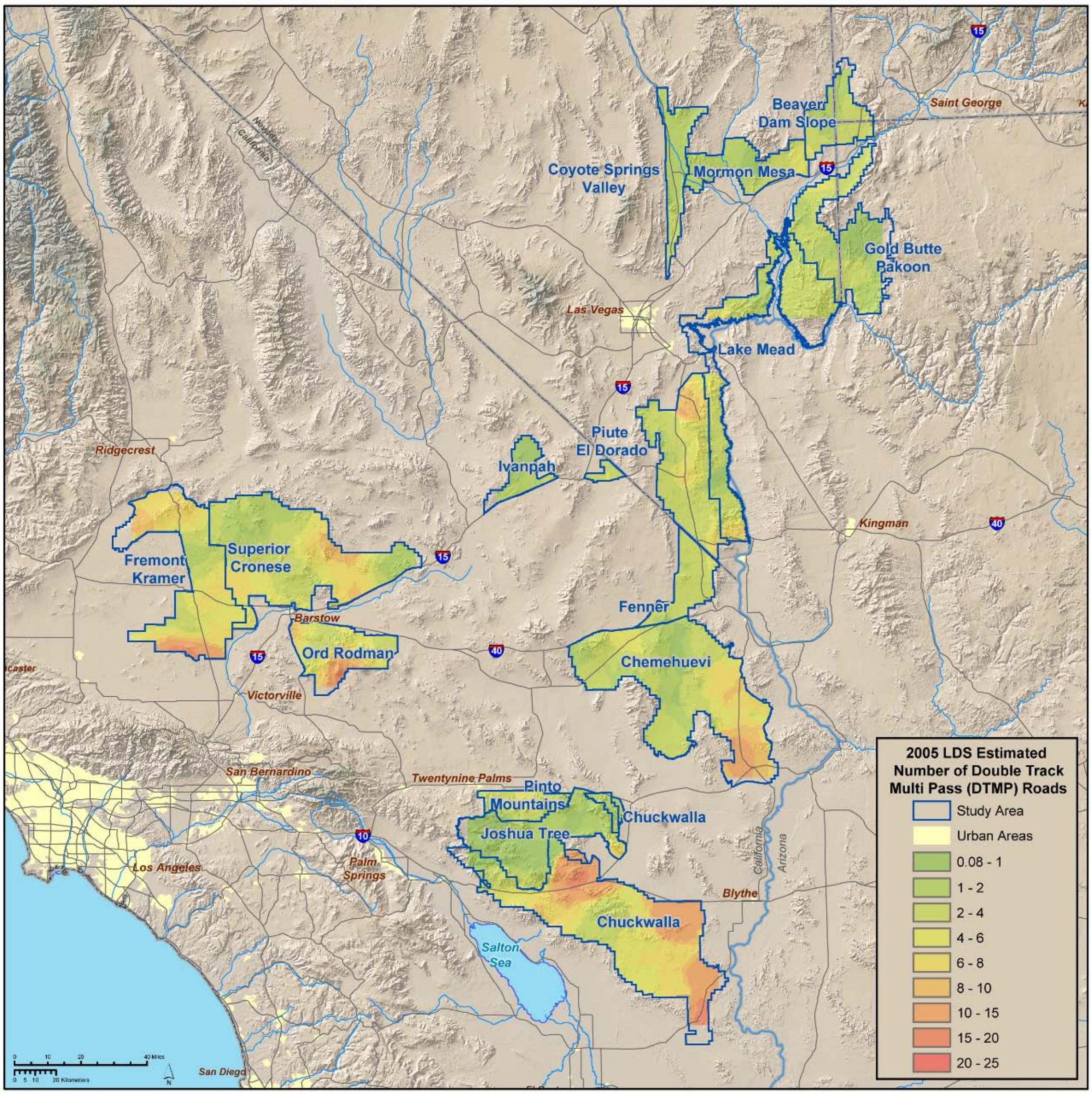

Figure 10. Estimated number of double-track multi-pass roads per 1 km^2.

All Double-Track Roads

In contrast to all other roads types, the highest concentration of double-track roads was within the Eastern and Northern Colorado RUs, not the Western Mojave RU (Figure 11). The Western Mojave RU was not without double track roads, but by far the highest concentrations were within Chuckwalla and Chemehuevi. One possible explanation for the high numbers in Chemehuevi could be the popularity of the Chemehuevi Wash as a recreation area. Five outliers were removed from the analysis, three in Chuckwalla and two in Superior-Cronese (spillover from Ft. Irwin National Training Center).

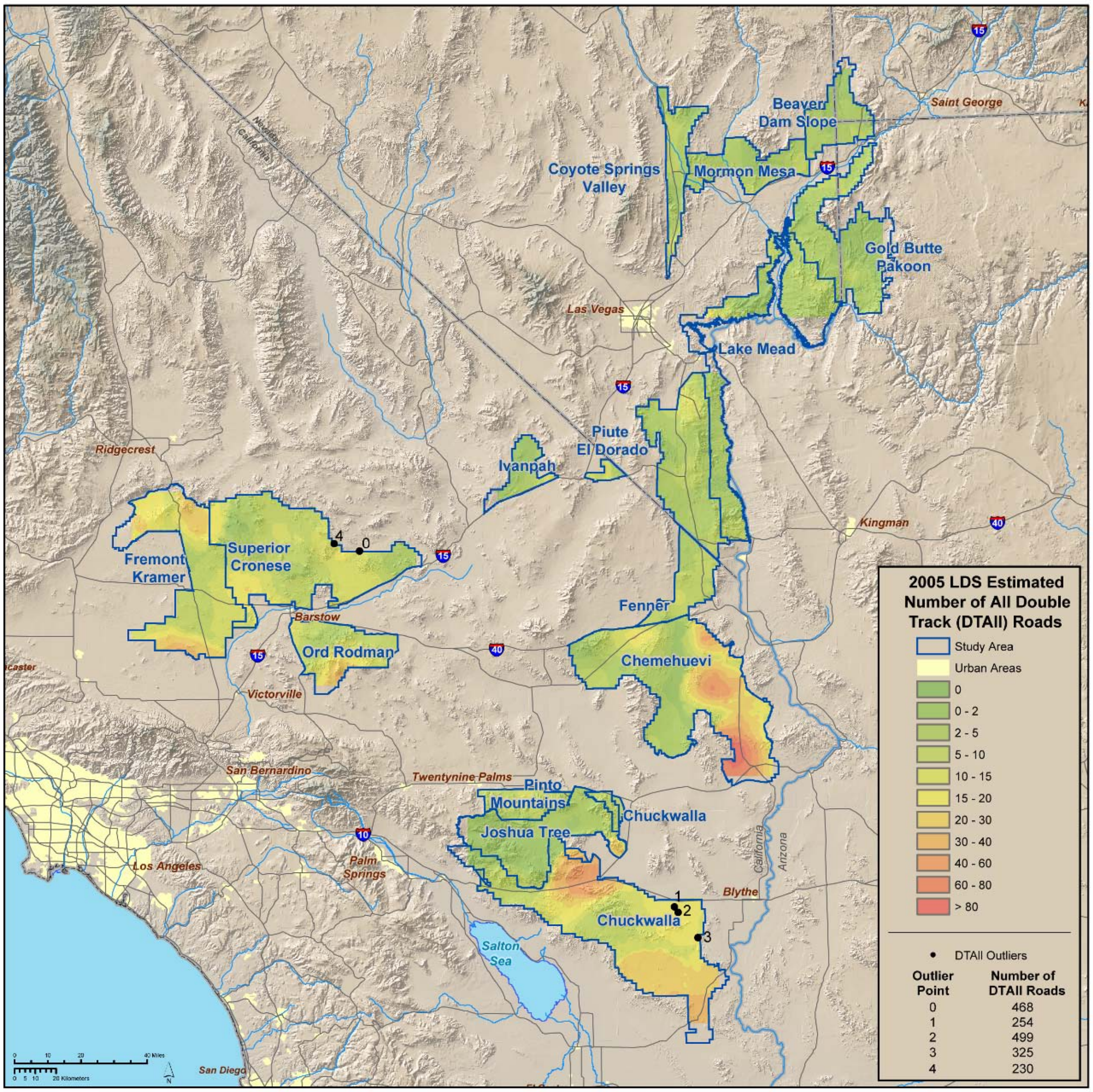

Figure 11. Estimated number of all double-track roads per 1 km^2.

Roads of all Types

When all road types were combined (i.e. graded, ungraded, double-track single-pass, double-track multi-pass, single-track single-pass, and single-track multi-pass), the highest concentration was within the Western Mojave RU, in particular Fremont-Kramer, followed by Superior-Cronese and Ord-Rodman (Figure 12). Within the remaining RUs all road types tended to be concentrated for the most part around major highways, interstates, populated places, or open OHV areas. A total of 18 outliers were removed before analysis. These values ranged from 203-1275. Half of these 18 outliers were restricted to the northern portion of Fremont-Kramer, the three most extreme outliers were all within Fremont-Kramer, and 13 of the 18 were within the Western Mojave Recovery Unit.

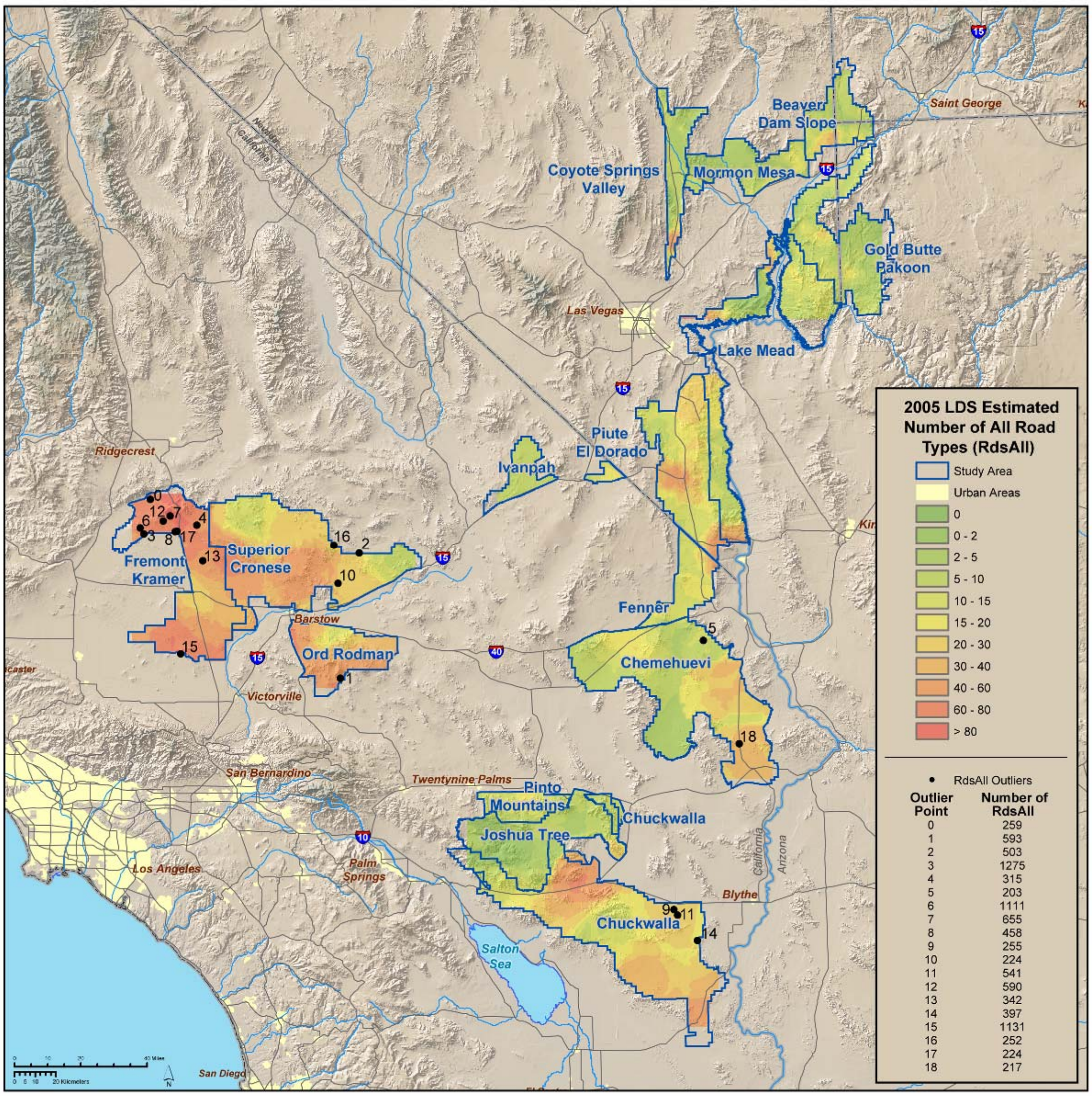

Figure 12. Estimated number of roads of all types per 1 km^2.

The earliest recovery recommendations for the desert tortoise described the threat from roads and identified geographic areas of particular concern (U.S. Fish and Wildlife Service, 1994). The following excerpt from the DTRPAC report (Tracy et al. 2004) underscores the continuing focus on roads as a threat to desert tortoises:

> Roads are conduits by which humans come into contact with tortoises. Hence, understanding the relationship between the presence of roads and tortoise population dynamics may be important to formulating desert tortoise recovery strategies. The original Recovery Plan recommended: 1) prohibiting vehicles from driving off roads; 2) restricting proliferation of new roads; 3) closing vehicle access to all but designated routes; and 4) implementing emergency closures of unpaved roads and routes as needed to reduce human access and disturbance in areas where human-caused mortality may have caused negative population trends. The plan also specifically highlighted the need to halt unauthorized off-road vehicle use in the Fremont-Kramer DWMA.

The report also recommended collecting data that would allow for exploration of the potential relationship between tortoise population dynamics and/or tortoise habitat with the presence of roads.

In all cases, regardless of road type, or summarized version, the West Mojave Recovery Unit contained the highest concentration of roads, and in many cases, far exceeded that found in other RU's. The area of greatest concern continues to be Fremont-Kramer, particularly the northern and most southern sections as well as Superior-Cronese and Ord-Rodman in the areas immediately surrounding Barstow.

With few exceptions, all single track and to a lesser degree double track roads, whether they be single-pass or multi-pass, were most likely the result of illegal off-road travel. Although there are large open off-road vehicle areas in the vicinity, none of these areas are part of the sample area, though Ord-Rodman is bordered on the west and south and Chuckwalla on the west by open OHV areas. Off-road travel is illegal other than that on designated routes in all DWMA's, critical habitat units, and National Park Service lands with the exception of wash zones in the Northern and Eastern Colorado Recovery Unit.

Exotic Vegetation

Nutrition is important to desert tortoise population biology because of the role it plays in growth, health, and fecundity (Tracy et al., 2004). Exotic vegetation bears directly on the availability of adequate nutrition because of its role in fire cycles, fugitive dust, biological availability of water, perhaps tortoise movement, and the nutritional value of the exotic plant itself (Tracy et al., 2004). The 2004-2005 winter was an extremely high rainfall year leading to high plant production and biomass. In a less productive year we might expect to find different levels of plant detection and thus different distributions.

Brassica tournefortii

The following information was taken from M. Brooks' *Invasion History and Patterns of Spread by Sahara Mustard (Brassica tournefortii) in the Southwestern North America* (http://www.cal-ipc.org/ip/research/saharan/pdf/SahMustInvasionPatterns.pdf, accessed 20 September 2006). *Brassica tournefortii* was first introduced into the Coachella Valley of the Colorado Desert in the early 1900s. By the 1950s it started spreading east through the Sonoran Desert, and by the early 1980s north into the Mojave Desert. Roadsides are reported as the primary pathway of spread, though recent patches were found in 2005 not characteristic of past areas. Disturbances known to facilitate the spread of *B. tournefortii* include paved roads, dirt roads, borrow pits along roads, fire, off-highway vehicle areas, and natural washes, particularly those that cross or are in close proximity to these disturbances.

The 2005 data are consistent with the information presented above (Figure 13). The majority of the concentrations of *B. tournefortii* were in the Colorado Desert and were near roadways (paved and dirt) as well as urban areas. The most alarming finding however was the concentration of *B. tournefortii* within the Pinto Basin region of Joshua Tree National Park. Roads are few and off road vehicle travel is strictly prohibited and strongly enforced in the Park. I recommend that these preliminary finds be brought to the attention of Park personnel immediately.

Schismus spp.

There appears to be virtually no areas sampled that did not contain *Schismus* spp. (Figure 14).

Bromus spp.

Bromus spp. are very well established in the Northern Mojave RU, as well as portions of the Western Mojave RU (Figure 15). *Bromus* spp. are not well established in the Northern and Eastern Colorado RU except the higher elevation and wetter Old Woman Mountains in Chemehuevi and the Little San Bernardino Mountains of Joshua Tree National Park. The Little San Bernardino Mountains have been heavily impacted by wildland fires in the last 5-10 years. The spread of *Bromus* spp. is greatly facilitated by such disturbances as fire, off-highway vehicle activities, overgrazing, and agriculture.

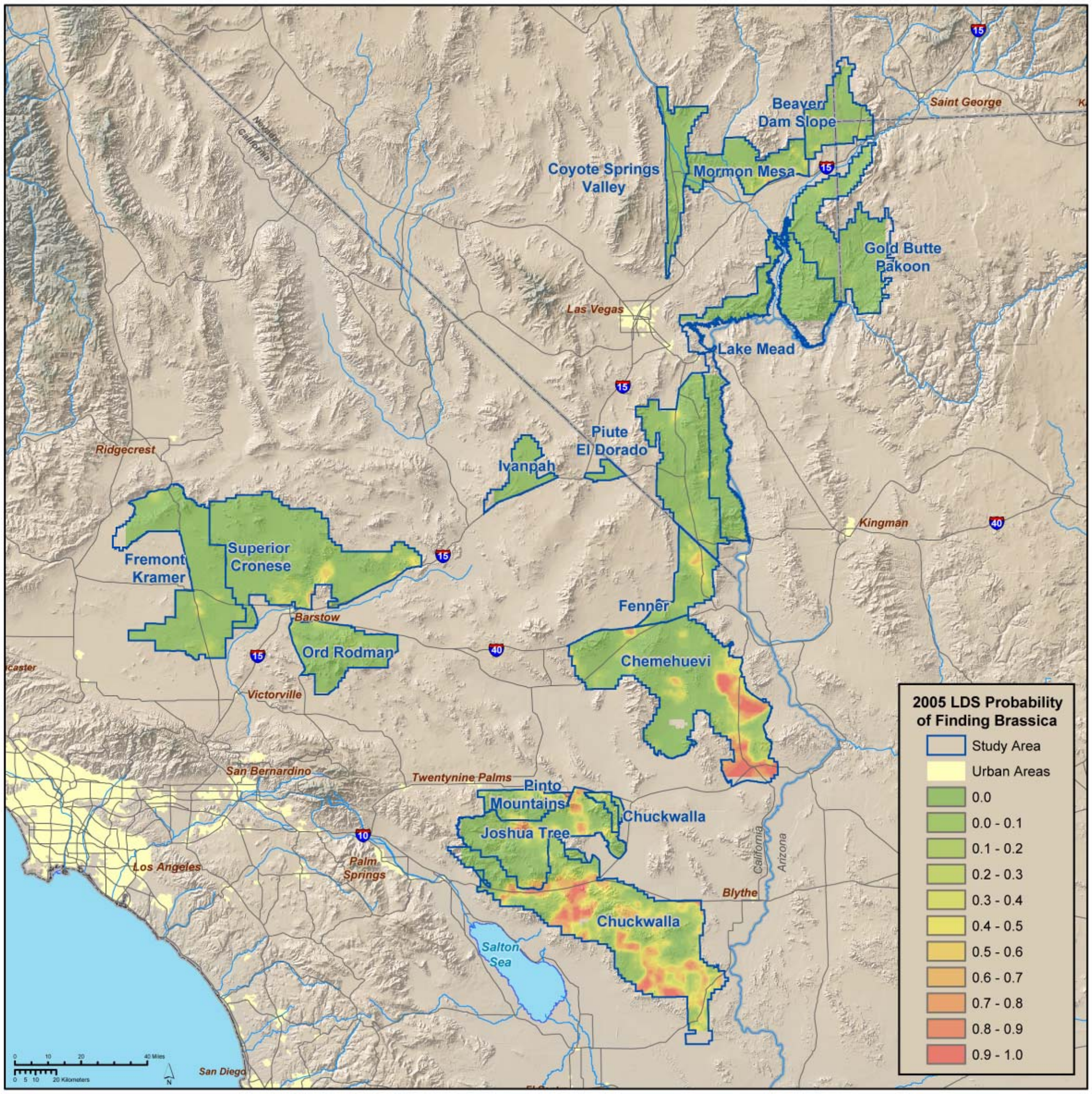

Figure 13. The probability of finding *Brassica tournefortii* per 1 km^2.

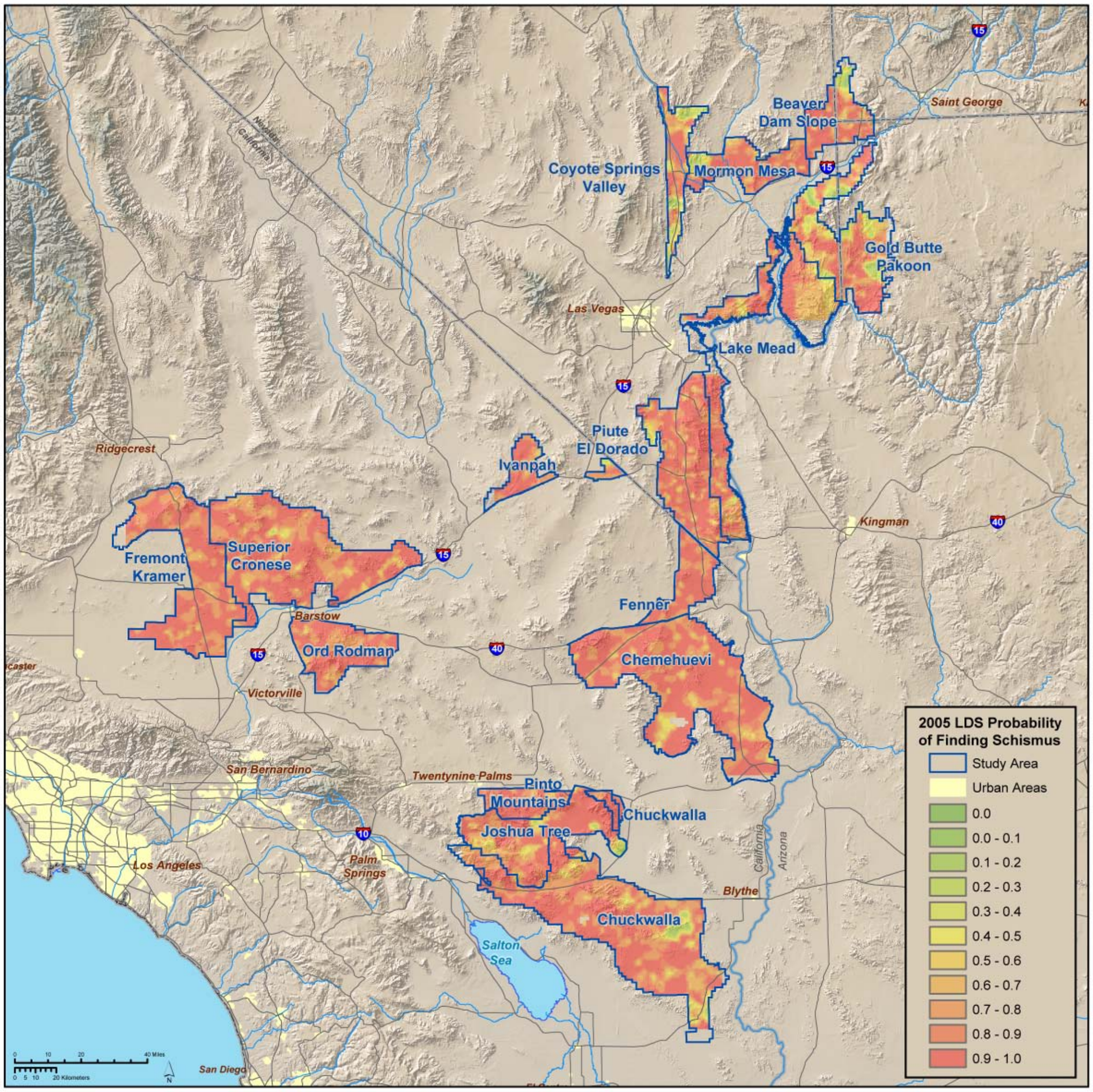

Figure 14. The probability of finding *Schismus* spp. per 1 km^2.

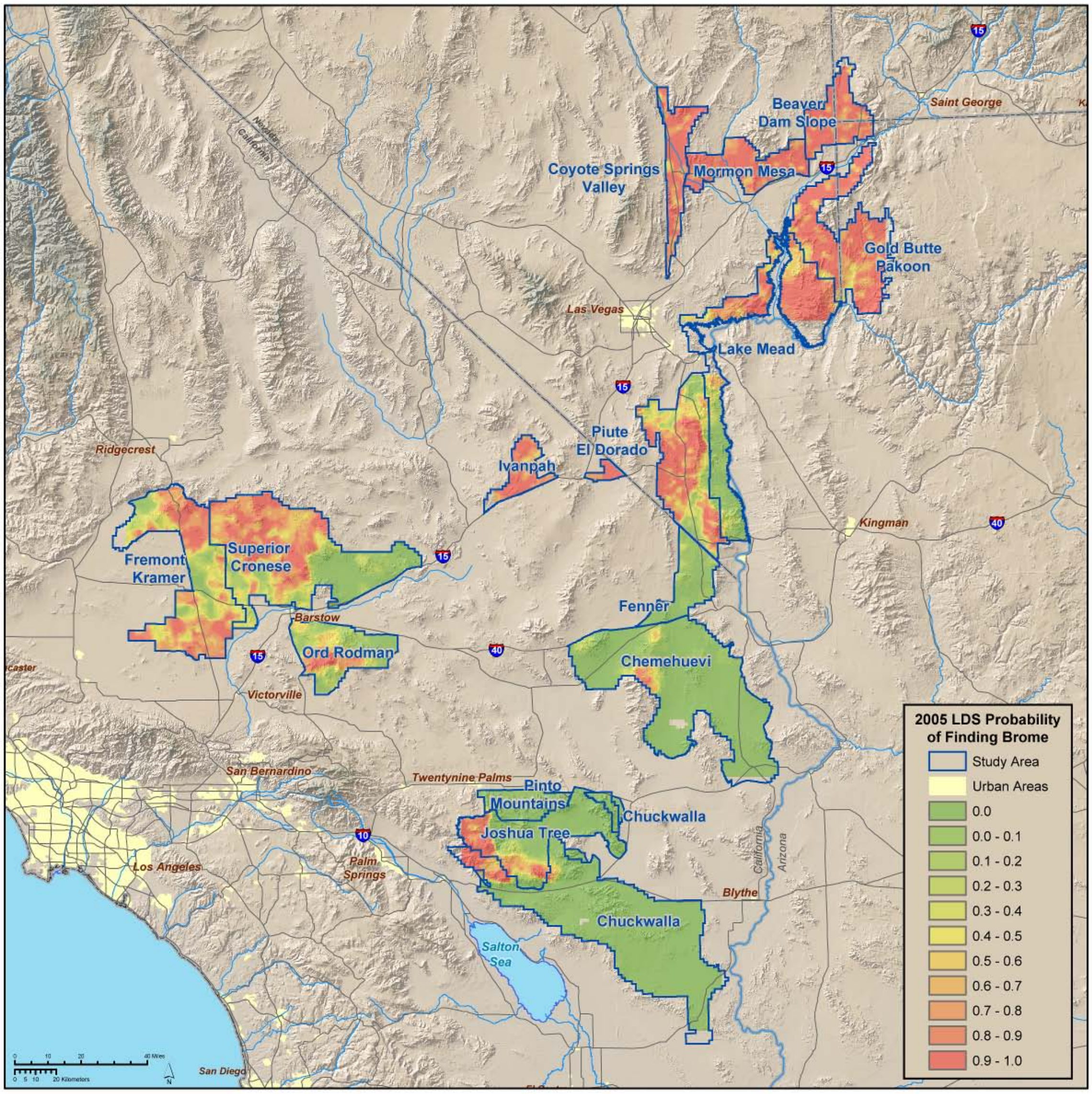

Figure 15. The probability of finding *Bromus* spp. per 1 km^2.

Canids, Trash and Ravens

In the planning phases of the 2005 distance-sampling season, two initiatives were newly underway by the California Desert Managers Group (DMG) that prompted the collection of canid and trash data. The first initiative was a written survey documenting reports of uncontrolled dogs in the desert. This survey ended in August 2005 (http://www.dmg.gov/feraldogs.php). The second initiative was illegal dumping prevention. This is an ongoing and active initiative that included a workshop in March 2006. In addition, a Raven Environmental Assessment Working Group specific to California was also initiated in the 2004-2005 timeframe and remains active today. The DMG, as well as Clark County, Nevada, remain active participants in raven management programs aimed at reducing risk to the desert tortoise. The raven data collected during the 2005 Distance Sampling season are by far the most comprehensive look at late spring/early summer raven distribution within desert tortoise habitat to date.

Canids

In the course of almost 9100 km walked in 2005 only three canids were observed (Figure 16). In California one canid was observed north of Hwy 58, just NW of Hinkley and a second east of Atchison just off of I-40. One canid was observed in Nevada south of Searchlight. Of the 431 tortoises observed in 2005, 26 were recorded as having some signs of probable canid trauma (Figure 17). An additional five tortoises where not recorded as having signs of probable canid trauma, however the notes field included comments on chewed or missing limbs. Nineteen of the 26 canid trauma tortoises were observed within the Western Mojave. Only tortoises recorded as canid trauma are included in Figure 17.

Trash

The probability of finding trash was very low throughout the entire sampled area and where it was found it was very near populated areas, even those only sparsely populated: Barstow, north of Adelanto, Randsburg, between Yermo and Manix, Homer, north of Vidal Junction, Chiriaco Summit, Searchlight, south of Boulder City and along Hwy 93 just into Coyote Springs Valley (Figure 18). There was one additional location in the Chuckwalla that was not associated with any obvious human presence.

Ravens

The fact that ravens prey on hatchling and juvenile desert tortoise is not in question, however the extent to which this predation has contributed to tortoise population declines remains unknown (Boarman, 2002). Raven distribution and numbers in the Mojave and Colorado Deserts are known to be effected by the availability of natural and anthropogenic resources, rather they are breeding, and season. The results presented here represent a single year and single time frame (late spring to early summer).

Raven observations were most high in the southern portion of Fremont-Kramer, north of the Victorville/Apple Valley area and within portions of Edwards Air Force Base (Figure 19).

Other areas of moderate presence included portions of Superior-Cronese and Ord-Rodman, along the sampled stretches of I-15 and I-40, a small portion of Chemehuevi and the southern area of Gold Butte-Pakoon in Arizona.

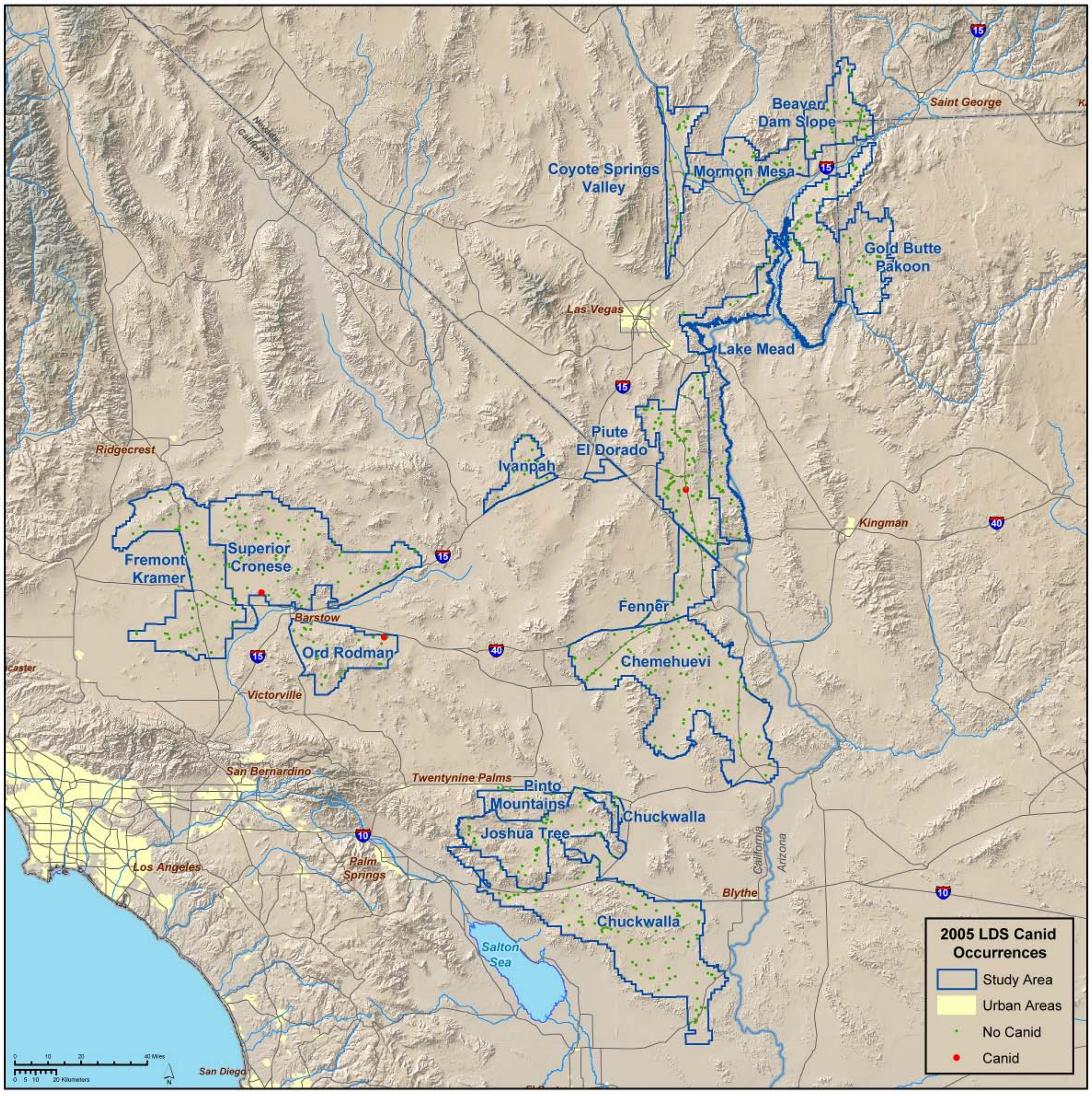

Figure 16. Map showing the three locations (red circle) were canids were observed.

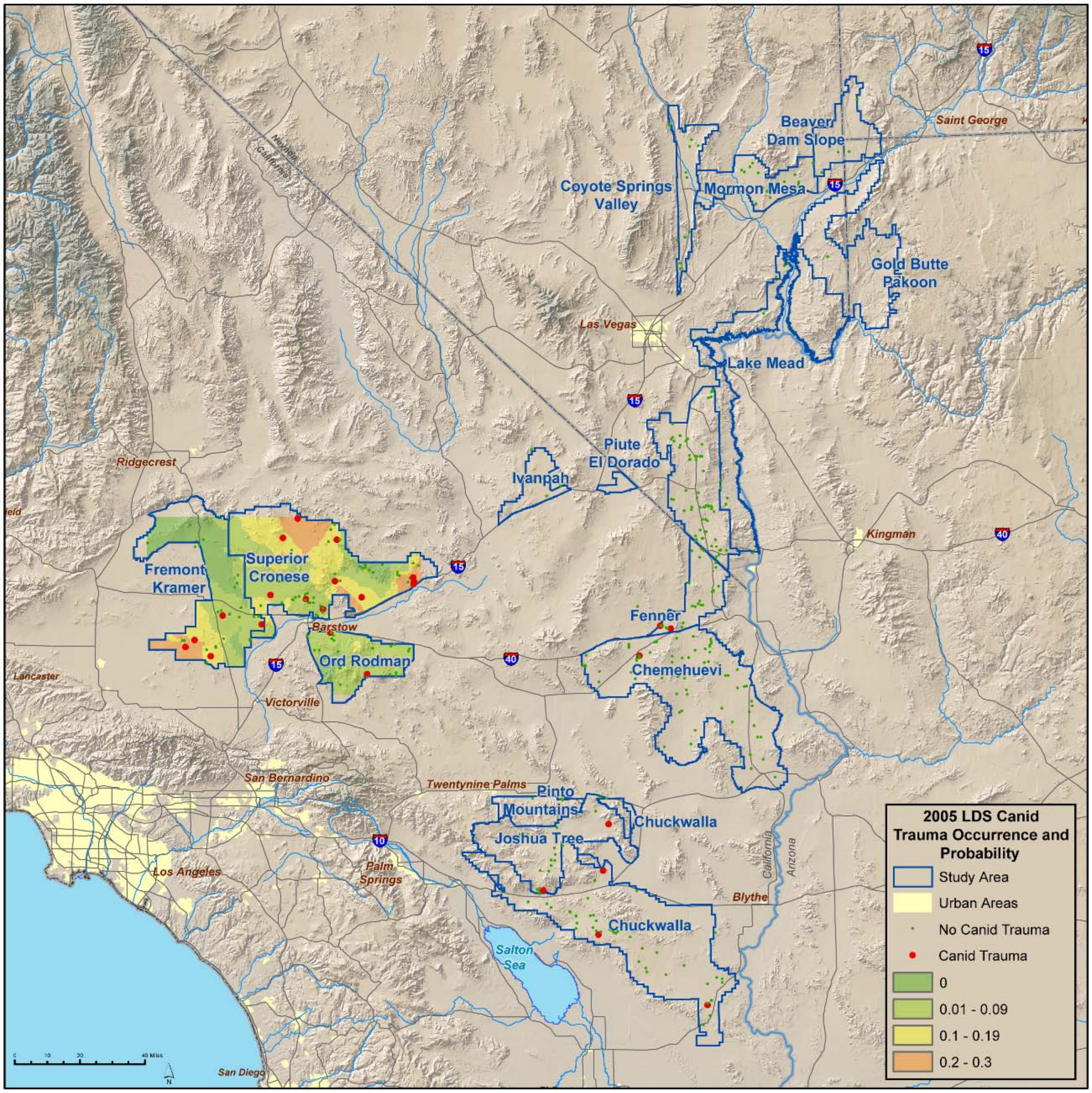

Figure 17. Map showing the locations were tortoises where observed that exhibited some signs of probably canid trauma.

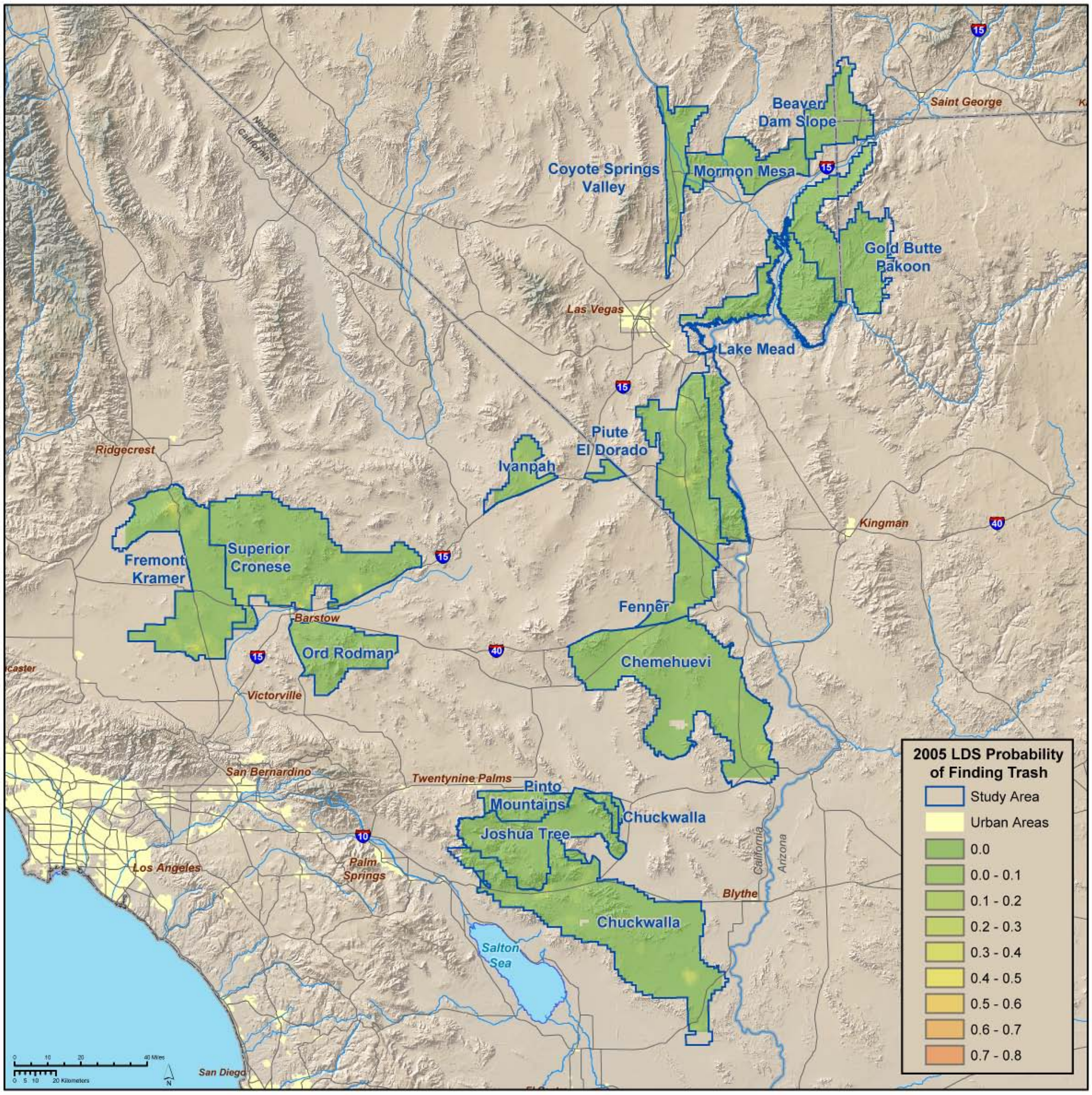

Figure 18. The probability of finding trash per 1 km^2.

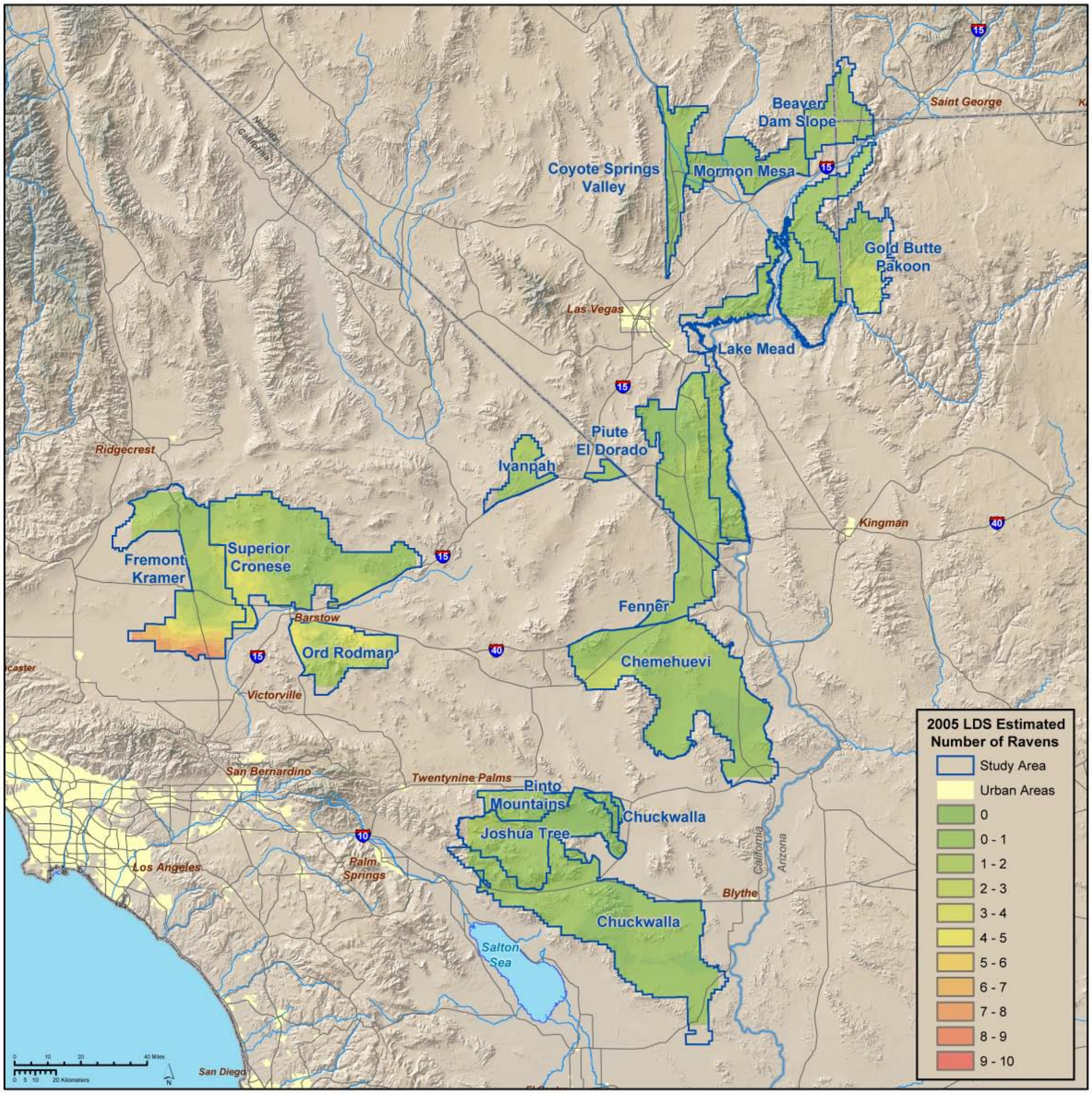

Figure 19. The estimated number of ravens per km^2.

Conclusions

This preliminary report captures modeled spatial patterns in some perceived threats at one point in time using basic spatial statistical tools. The value of integrating data on desert tortoise threats with local or regional information on trends in population status was identified in Tracy et al. (2004). Such monitoring would 1) be part of a coordinated, integrated effort that would achieve many objectives including description of trends for threats, 2) enhance the ability to develop correlation-regression models between abundance of desert tortoise, habitat, and threats, and 3) be part of a plan to develop monitoring of habitat and threats. Clearly, the patterns identified in this report are a preliminary step towards a more elaborate examination of threats and patterns across space and potentially with repeated sampling, across time.

However, this report is of obvious value for current uses as well, as a tool with direct and immediate implications for recovery management. Even as a snapshot in time, it focuses attention on the difference in threats from illegal off-road traffic in specific areas. It provides an instantaneous answer to questions about the prevalence of canids, as well as initiation of a baseline for perceived canid trauma in tortoises. The next steps will include refining and finalizing these spatial models for comparison with live and dead desert tortoise distributions.

LITERATURE CITED

Boarman, W.I. 2002. Threats to desert tortoise populations: a critical review of the literature. Unpubl. report to the West Mojave Planning Team and the Bureau of Land Management. U.S. Geological Survey, Western Ecological Research Center, San Diego, CA.

Tracy, C.R., R. Averill-Murray, W.I. Boarman, D. Delehanty, J. Heaton, E. McCoy, D. Morafka, K. Nussear, B. Hagerty, and P. Medica. 2004. Desert tortoise recovery plan assessment. Report to U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. 1994. Desert tortoise (Mojave population) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 73 pp plus appendices.

U.S. Fish and Wildlife Service. 2006. Range-wide monitoring of the Mojave population of the desert tortoise: 2001-2005 summary report. Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada.

APPENDIX I


Figure 1. Graded road.


Figure 2. Graded road.


Figure 3. Graded road.


Figure 4. Ungraded road.


Figure 5. Ungraded road.


Figure 6. Ungraded road.


Figure 7. Single track single pass.


Figure 8. Single track single pass.

Figure 9. Single track single pass.


Figure 10. Single track multi-pass.

Figure 11. Single track multi-pass.

Figure 12. Single track multi-pass.


Figure 13. Double track single pass.

Figure 14. Double track single pass.


Figure 15. Double track single pass.


Figure 16. Double track multi-pass.


Figure 17. Double track multi-pass.

Figure 18. Double track multi-pass.